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Two Sympatric, Sibling Species of *Eucalyptus* from the West Coast of Western Australia

By D. J. Carr* and Stella G. M. Carr*

Abstract: Two new species of *Eucalyptus* are described from the coastal areas and adjacent islands of Western Australia (lat. 24°45'S to lat. 29°S). They are assigned to the informal section of series Dumosae in which the testa is brown-netted. The two species closely resemble one another in gross morphology of buds and fruits but can be separated with certainty on characters of the venation and on oil gland size. The two species are sympatric in overall distribution and are sometimes found together in the same locality. One of these species (*E. baudiniana*) is named in honour of Captain N. Baudin, the Commandant of the voyage of discovery on which it was first collected. The other (*E. tamala*) is named from a locality where of the two, it alone occurs.

INTRODUCTION

In 1960 Gardner stated that *E. foecunda* Schau., a Western Australian species, was close to, if not identical, with *E. leptophylla* F. Muell. from South Eastern Australia. This concept has since been widely accepted. Subsequent to its original description, he added, *E. foecunda* had been 'confused by all who have written on *Eucalyptus* with another distinct species from the coastal districts between the Murchison River and Dongara, as well as Dirk Hartog Island and the Abrolhos. . . . The differences between the two are at present under investigation'. Gardner coined the manuscript name '*E. lucida*' (referring to its shining leaves) for this undescribed species. Examination of the specimens known to Gardner and of others since collected has enabled us to distinguish two species almost entirely on the basis of vegetative characters. These constitute the entity known to Gardner. The second species has almost the same geographical distribution as the first and superficially closely resembles it but can be readily separated from it (Fig. 1).

MATERIALS AND METHODS

The methods used in examination of the specimens were the same as those described by Carr, Carr and Milkovits, 1974.

The following specimens were examined:

1. A. S. George 11601, 7.9.1972. In white sand among open scrub. Nr. Notch Point, Tetrodon Loop. Dirk Hartog Island.
2. A. S. George 11607, 7.9.1972. In sand among open scrub. 7 m south of Homestead. Dirk Hartog Island.
3. R. D. Royee 5967, 19.7.1959. Red sand S. of Quoin Bluff, Dorre Island, Shark Bay.
4. R. D. Royce 5982, 21.7.1959. On ridges, red sandy soil, Bernier Island, Shark Bay.
5. R. D. Royce 6018, 23.7.1959. In red sand, Bernier Island, Shark Bay.
6. J. R. Ford Dec. 1964. 5 m NE. of Tamala.
7. P. G. Wilson 6717, 12.5.1968. 3 km E. of Kalbarri, near top of Limestone hill, Mcanarra Hill.
8. D. L. Serventy 63, no date. Wallaby (Wallabi) Island, Abrolhos.
9. A. R. Main 13.2.1963. E. Wallabi Island, Abrolhos.
10. C. A. Gardner 'D 59', 4.4.1945. 19 m E. of Perenjori on Damperwah Road.
11. N. T. Burbridge 2.9.1947. 7 m N. of Geraldton near White Peak.
12. D. J. & S. G. M. Carr 408, 17.3.1968. 16·2 km on road S. from Denham, Peron Peninsula.
13. D. J. & S. G. M. Carr 972, 25.8.1969. 58 km from Coastal Highway, on Bungabandi Creek Road.

A number of collections was made by S. G. M. Carr in 1966 along the road to Tamala

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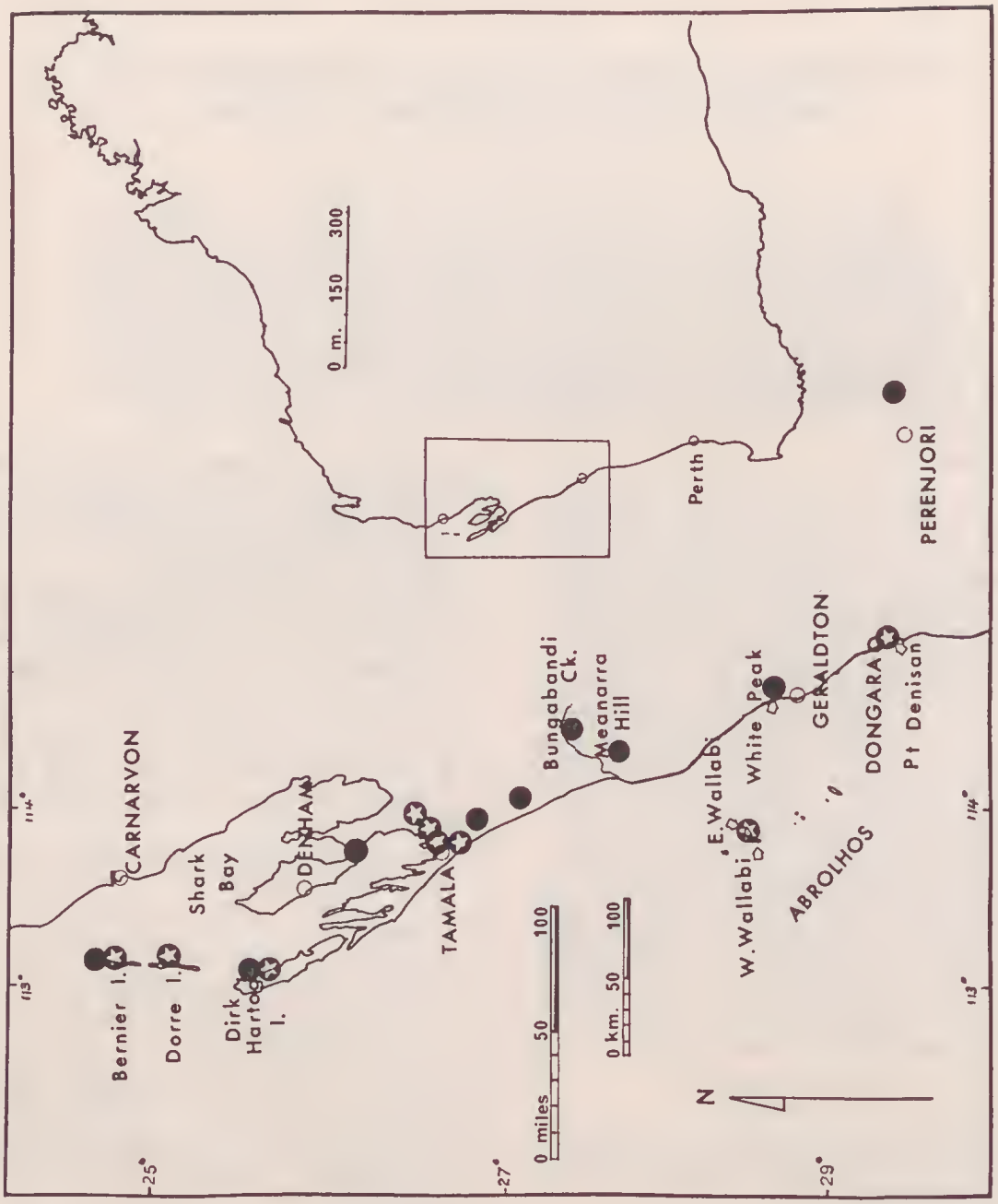


FIG. 1.—Map showing localities of collection of specimens of Group A ● and Group B ⊖.

Station at distances between 16 and 42 km from the turn-off from the Denham road (Carr 390-394, March 1968). Another four collections were made in 1968 in the same area (Carr & Carr 1002-1005, August). Specimens 1-11 are housed in the Western Australian Herbarium (PERTH). In addition the following materials from the New South Wales Herbarium have been examined:

E. oraria L. A. S. Johnson, holotype. L. A. S. Johnson, 10.12.60, N.S.W. 54051, 'About 5 m N. of Dongara'. (The locality appears to be at least uncertain, possibly unknown. The original locality given on the label, '5 m north of Geraldton', has been crossed out and the one cited above substituted. Presumably the specimen was collected on or near the NW. Coastal Highway. Localities along a long stretch of this road have been searched in vain by several botanists).

W. A. Oldfield, Murchison River. N.S.W. 54052.

Capitaine Baudin, 1801. Côte occidentale de la nouvelle Hollande. N.S.W. 54053.

J. Drummond, 2nd collection 87, 1884. N.S.W. 54054.

These three old specimens are cited by Johnson (1962) as identical with *E. oraria*.

Following the publication of Chippendale's (1974) list of photographs of *Eucalyptus* specimens held in Europe, the following specimens from Kew, all labelled '*E. oraria*' were examined:

C. Baudin, West Coast (Kew negative no. 602): 'to Governor King, see the specimen in Herb. Banks, of which this is a fragment given me by Mr. Dryander'. This presumably refers to the Baudin specimen mentioned in Bentham (1867) under *E. foecunda* Schau.

Oldfield, Yatthoo Flat, Limestone Hills, Murchison River (labelled Sheet 1, Kew negative no. 603).

Oldfield, Murchison River ('spear-wood') (labelled Sheet 4, Kew negative no. 606).

RESULTS

The W.A. specimens and those of our own collection can readily be classified into two groups (listed in Table 1). Group A has coarser venation, simpler marginal venation and larger oil glands than Group B. Once comparisons have been made between some specimens of the two groups other specimens can be sorted using a hand lens. However, the use of vegetative characters in the identification and classification of eucalypts is unconventional and we have therefore subjected most of the specimens at our disposal to a rigorous and detailed examination. The results of this comparative examination are set out below.

TABLE 1

MEANS OF MEASUREMENTS OF MAXIMUM DIAMETERS OF 50 OF THE LARGEST OIL GLANDS

Specimen	*Mean diameter* (*μm*)
GROUP B	
Serventy, Abrolhos	28·0
Oldfield, Yatthoo Flat (Kew)	29·0
Carr, 394, Tamala	32·0
Ford, Tamala	32·3
Royce, 6018, Bernier Island	33·8
A. S. George, 11601, Dirk Hartog Island	34·5
Royce, 5967, Dorre Island	35·8
Carr, 393, Tamala	36·7
GROUP A	
Carr & Carr, 972, Bungabandi Creek	44·4
Burbidge, White Peak	45·3
Baudin, Côte occidentale (N.S.W. specimen)	45·5
Royce, 5982, Bernier Island	46·4
Gardner, Perenjori	48·0
Oldfield, Murchison River Sheet 4 (Kew specimen)	48·2
Baudin (Kew specimen)	48·7
A. S. George, 11607, Dirk Hartog Island	49·8
P. G. Wilson, Meanarra Hill	52·0
Carr & Carr, 408	52·0

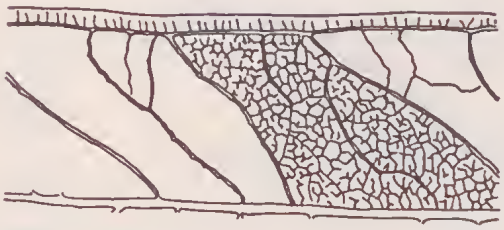
(1) *Venation:* Representative adult leaves of the specimens were cleared and photographed (Pl. 1) and drawings were made of the venation. Some of these drawings are arranged for comparison in Fig. 2. They show a clear difference between specimens in the coarseness of the ultimate venation, i.e. in the size of the smallest vein islets. This difference persists irrespective of the relative sizes of the leaves and their general shape, although these factors have consequent effects, of course, on the main venation pattern. Consistent differences in costal vein angles to the midrib, the numbers or thickness of costal veins or the thickness of the midrib, between patterns of dissection of the panels of lamina between costal veins by subordinate veins, or of branching patterns of the subordinate veins cannot be discerned. Nevertheless, the leaves of Group A give the overall impression of being more coarsely veined than those of Group B, consistent with the obvious differences in scale of the ultimate venation shown in Fig. 2.

(2) *Marginal Venation:* Photographs of the marginal venation at about the midpoint of representative adult leaves of different specimens are grouped in Pl. 2. Two patterns are revealed:

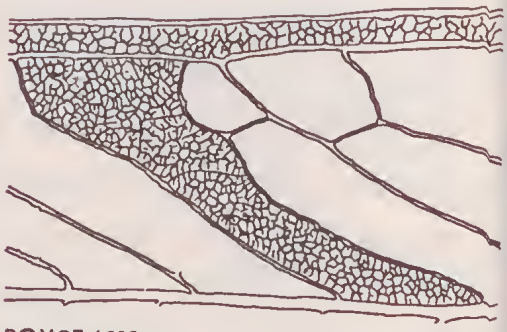
In specimens of Group A the space between the marginal vein (often called the 'intramarginal vein') and the margin of the leaf is crossed by simple, short ribs dividing the space into rhom-

A.S.GEORGE 11607

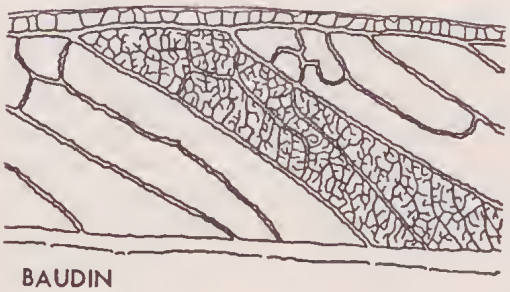
A.S.GEORGE 11601



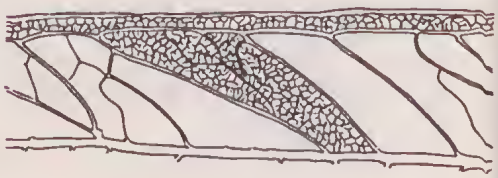
ROYCE 5982



ROYCE 6018

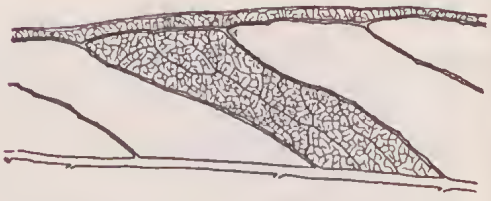


BAUDIN



SERVENTY

CARR & CARR 972



CARR & CARR 393

FIG. 2—Drawings, made from photographs, of the venation patterns of the middle portions of adult leaves, representative of specimens of Group A (all to the left) and Group B (all to the right). The Baudin specimen is N.S.W. 54053. (All × 2·4.)

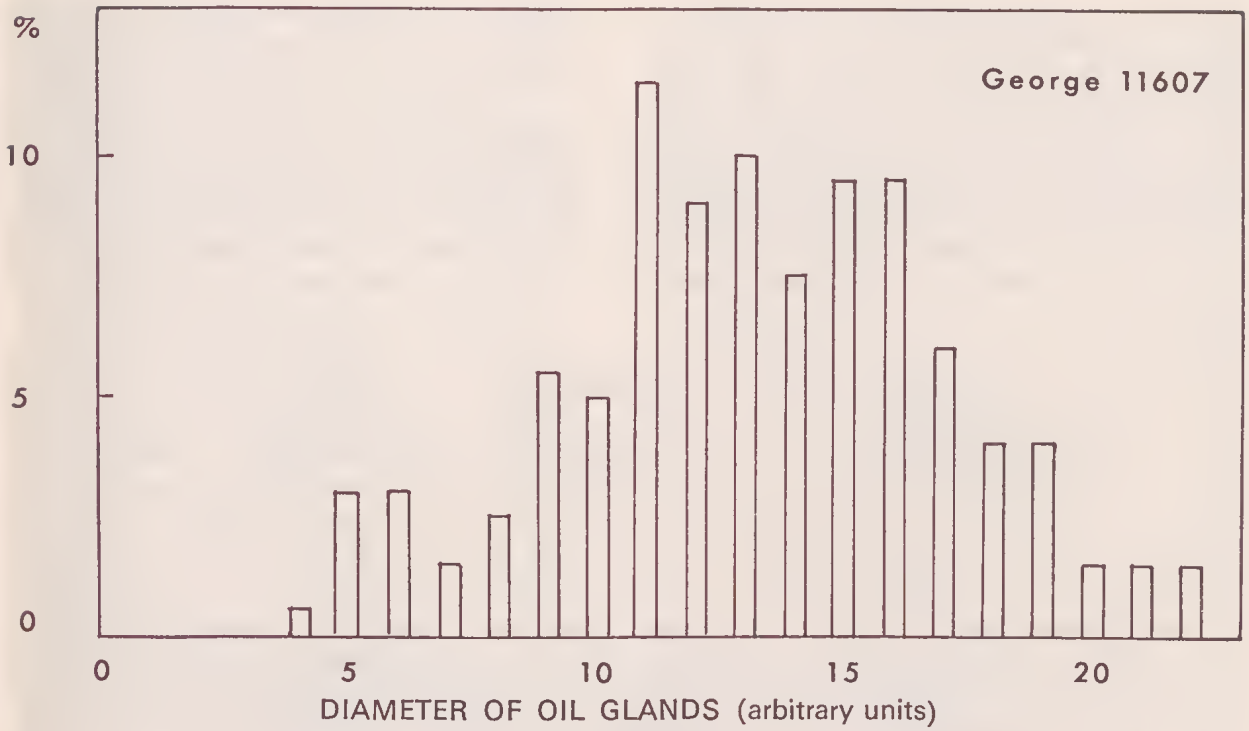


FIG. 3—Graph of the frequency of distribution of the diameters of 200 oil glands of adult leaves of George 11607.

boidal frames, each of which may contain one or two oil glands. These ribs are either unbranched or may bear short extensions into the frames; these extensions are minute venules which mostly terminate in the frames themselves.

In specimens of Group B the space between the marginal vein and the margin is divided into relatively large and irregular areas by much-branched vein loops, extending from the marginal vein. These areas are filled with a complex reticulum of finer venation and each may contain numerous oil glands. This character is always associated with the finely reticulate venation of the rest of the leaf, characteristic of specimens of Group B.

The differences in marginal venation between the two Groups are best developed in leaves of adult form and examination of the margins at about the middle third of such leaves with a hand lens should suffice to classify specimens.

(3) *Oil Glands:* Table 1 shows that measurements of the oil glands also allow the specimens to be sorted into two groups. Since any leaf will have a wide range of sizes of oil glands it is necessary to explain how measurements of this kind can be used to make comparisons. The first oil glands in the leaf appear in association with the midrib, when the leaf primordium is only a few mm long. Oil glands are also initiated in association with the marginal veins, which are the next element of the venation to be blocked in. These early oil glands continue to enlarge for a time during the further expansion of the leaf and they therefore eventually constitute some of the largest oil glands of the mature leaf. As the main costal venation is blocked in, oil glands appear between the lateral veins. By the time the leaf is about half its mature width there are more than a dozen developed oil glands—usually those which will attain the intermediate sizes—in each of the panels bounded by main lateral veins. As the vein islets are blocked in they also acquire oil glands, the smallest of which occupy the smallest territories within the venation pattern. All of these oil glands continue to expand after initiation, at first rapidly then very slowly until the maximum size (which is partly determined by the number of epithelial cell layers initiated) is reached. Oil glands cease to be initiated and expand before the leaf reaches its maximum size. The population of oil glands consists, therefore, of a number of sets each corresponding roughly to a stage of blocking in of the venation and consequently of diminishing initial and maximum size. A frequency distribution of diameters of oil glands is therefore not normal but consists perhaps of several overlapping distributions (Fig. 3). Direct statistical comparisons between

the sizes of oil glands of different specimens are therefore difficult, despite the fact that visually the oil glands of a given specimen may collectively be obviously smaller than those of another. We have therefore chosen to use a simple, practical discriminant. This is the mean maximum diameter of 50 of the largest oil glands which can be found in microscope fields along the marginal vein and near the midrib of cleared leaves. In surface view oil glands are approximately spherical but large ones near the margin may become ellipsoidal during expansion of the leaf. The measurement is taken along the longest diameter of the whole of the lumen of the gland. The measurements are not amenable to simple statistical treatment. Fortunately, in the present instance, the differences support the results of visual comparison and are large enough to be convincing. Using this criterion the specimens again separate into the same two groups (Table 1) as are found using venation criteria.

(4) *Phytoglyphic Analysis:* By this we mean (Carr, Milkovits & Carr, 1971) an examination by scanning electron microscopy of the surface features of the leaf cuticles, and by light microscopy of stained cuticle preparations and of thin (1-2 μm) sections of leaves. Scanning electron microscopy revealed no differences of value to the present study. The cuticles are uniformly plane, without ornamentation, even around the stomata. On the basis of details of the stomata in median section (at right angles to the length of the pore) the specimens fall into two groups (Pl. 3). Specimens of Group A have stomata in which the edges of the outer cuticular 'flaps' are often bent inwards towards the guard cells and are not raised above the level of the surrounding cuticle. The flaps of the stomata of Group B, on the other hand, are often raised well above the level of the surrounding cuticle and tend to form an arch above it. The sections shown in Pl. 2 are chosen to represent configurations typical of the majority of the stomata to be found on the 'free' part of the lamina of the leaf. Near the margin of the leaf, where the cuticle is thicker, the stomatal sections may have a different shape, the cuticular flaps are often larger and more erect. In addition, eucalypt stomata are dimorphic (Carr & Carr, in preparation). A minority (1-5%) are much larger and of a different form. Our comparisons here refer to the majority of the stomata found between the midrib and the margin. The anatomy of the cuticle itself shows some differences between the specimens. The thin outermost layer of the cuticle of Carr and Carr 972 is birefringent. This birefringent layer may in part be responsible for the very shiny appearance of the leaves which led Gardner to the name 'lucida'. The Tamala trees also had somewhat shiny leaves and the leaves of Royce's 5982

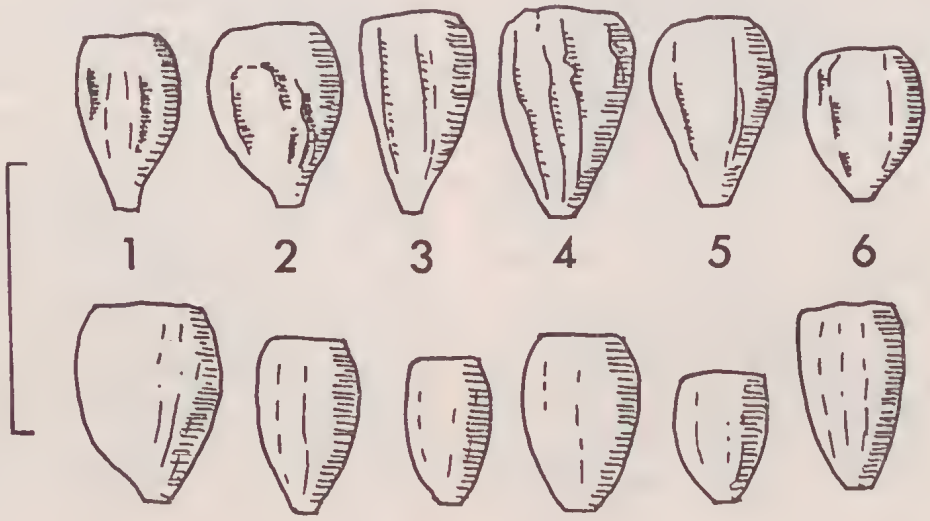


FIG. 4—Drawings, made from photographs, of representative fruits of specimens of Group B (upper row) and Group A (lower row). Upper row: 1. George 1101. 2. Royce 6018. 3. Royce 5967. 4. Carr & Carr 393. 5. Carr & Carr 394. 6. Ford. Scale line on left equals 1 cm. Lower row: 1. George 11607. 2. Royce 5982. 3. Carr & Carr 972. 4. Wilson. 5. Burbridge. 6. Gardner.

(from Bernier Island) (Group A) were recorded as 'shining' so it appears that this is not a discriminant field character. All the specimens have a birefringent inner zone of the cuticle.

(5) *Fruits:* As is usually the case in eucalypts, the fruits of a given specimen are relatively uniform in size and shape, but there is a wide range in both size and shape between the fruits from different collections. In general it would be difficult to assign fruits to Group A or to Group B, as determined on vegetative characters. Nevertheless, the fruits of Group A are generally thinner-walled and smaller than those of Group B and they differ subtly in shape (Fig. 4). In Group A the fruits are sessile or very shortly stalked, light brown when mature. They vary in size from 4-7 mm long by 3-5 mm wide. They are usually subcylindrical, narrowed gradually to

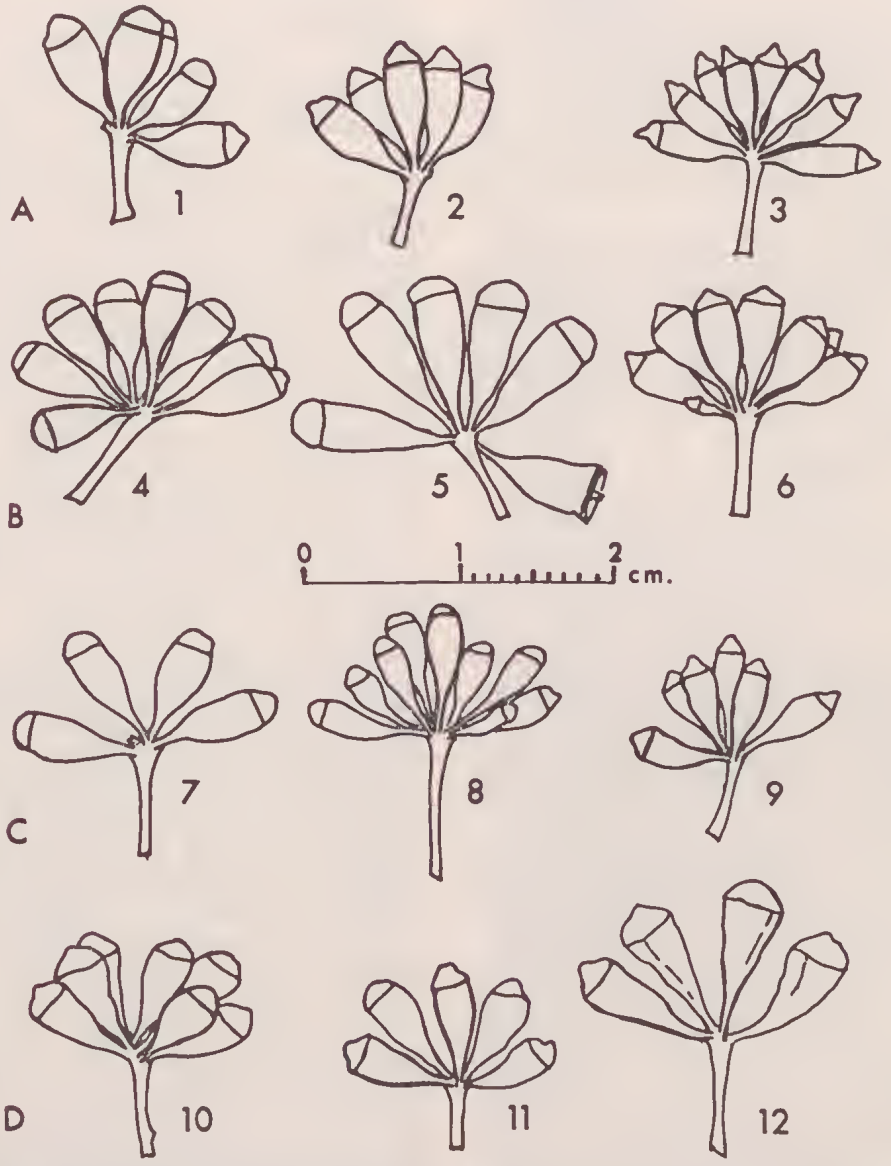


FIG. 5—Drawings of mature flowers; rows A and C, Group A. Rows B and D, Group B. For comparisons, the George specimens are numbers 1 and 4, the Royce specimens from Bernier Island, numbers 2 and 5. 1. George 11607. 2. Royce 5982. 3. Carr & Carr 972. 4. George 11601. 5. Royce 6018. 6. Carr & Carr 1004. 7. Wilson. 8. Serventy. 9. Gardner. 10. Ford. 11. Royce, Dorre Island 5967. 12. Carr & Carr 1003.

the orifice, the maximum diameter being at a distance of 30% of the length or more below it. There are 3 or 4 loculi. The valves are triangular with short blunt tips, sunk (in some specimens deeply) below the level of the orifice.

In colour, shape and position of valves, number of loculi and length of stalk the fruits of Group B resemble those of Group A. However, they tend to be larger, ranging in size from 5-9 mm long by 3·5-5 mm wide. They are pyriform or conical, *abruptly* narrowed to the orifice from a maximum diameter only 20% or less of the length below the orifice. The fruits of Group B are thick-walled, more or less furrowed or even *sulcate*. Those of Group A are smoother, usually only slightly furrowed. The depth of insertion of the valves is often (but not invariably) deeper below the orifice in the fruits of Group A than in those of Group B.

One interesting point is that the fruits of specimens of the two Groups from adjacent localities tend to resemble each other to some extent. Thus the fruits of George 11601 and 11607 from Dirk Hartog Island have similarities of shape, as do the two Royce specimens from Bernier Island (Fig. 4). On the other hand the Tamala specimens—all of Group B—show a wide range of size but not of shape.

(6) *Flowers:* The inflorescences are stalked and consist of 7 to 15 flowers. They are axillary and atonic (i.e. distributed along the annual shoot and not restricted to any particular region of it). Flowers are formed and become fully developed in a single season. No consistent differences in the position or composition of the inflorescences or in the anatomy of the flowers themselves by which specimens of Group A, distinguished by vegetative characters, are separable from specimens of Group B. There are differences between individual specimens in flower size and shape and these entrain consequent differences in anther and ovule size and shape. The operculum is rounded in some specimens, apiculate in others but these differences bear no reference to the two groups based on vegetative characters. However, just as the fruits of specimens of the two Groups from adjacent localities may tend to resemble one another in shape, so also, in some cases, do the flowers (Fig. 5). It is noticeable that in the same locality the flowers of specimens of Group A (like the fruits) tend to be smaller than those of Group B (Fig. 5 cf. 1 and 4, 2 and 5). However, at Tamala a wide range in size is shown by the flowers of the trees which are all of Group B.

In the flower bud the stamens are all inflexed and at least the outer filaments have some oil glands. The anthers are all potentially fertile (i.e. there are no regular staminodes). The anthers are versatile, the outer ones tapering, in outline resembling a truncated inverted triangle. The gland in the connective is sub-terminal and not visible from the front (adaxial) side of the anther. The anthers open by slits parallel to their length. The style is usually shorter than the dome of the inflexed stamens. The stigma is hemispherical and wider than the style. The style contains oil glands. The ovular structures are in four longitudinal rows and up to 15 to 16 transverse rows. There are as many as 10 rows of ovules, on the margins of the placenta.

(7) *Seeds:* Seeds are present in very few of the collections available for examination. Seeds were available from the two A. S. George specimens, from those of Main and Wilson and from our own collections. All the seeds conform to the third group of the informal category 'Dumosae' of Carr and Carr, 1969: 'the third group has brown seeds without wings and with a shallow, dark netting of anticlinal cell walls on the surface'. (The quoted passage goes on to say that this group includes '*E. oraria*' but this referred not to the Johnson holotype but to our own Tamala collections.) The number of seeds per capsule is small—one or two per loculus, often fewer. The specimen A. S. George 11601 had few capsules and these produced fewer than half a dozen seeds in all. Some of the flowers of this collection proved on examination to be functionally male (Carr, Carr & Ross, 1971). The size of the seeds bears a relationship to the size of the flowers and fruits and there are marked differences in shape (Fig. 6) but neither size nor shape bears a relationship to the grouping established on vegetative characters.

(8) *Seedlings:* It proved possible to raise seedlings from seeds of our own collections and from the two made by A. S. George. In all cases the cotyledons are reniform. The seedling leaves are opposite for 7-9 pairs in the Tamala seedlings and for 5-7 pairs in the seedlings from Carr and Carr 972. The Tamala seedlings developed small lignotubers by the time they had about 15 pairs of leaves, but the Carr and Carr 972 seedlings had not developed them even after another 10 leaf pairs had been laid down. The seedling leaf shape is quite different in the two sets of seedings (Fig. 7). The early leaves—up to node 6—of Carr and Carr 1004 (the seedlings of which are typical of those of the Tamala specimens) are ovate, at least half as broad as long, sometimes broadly pointed. The early seedling leaves of Carr and Carr 972 are broadly lanceolate, and they are longer and narrower than the corre-

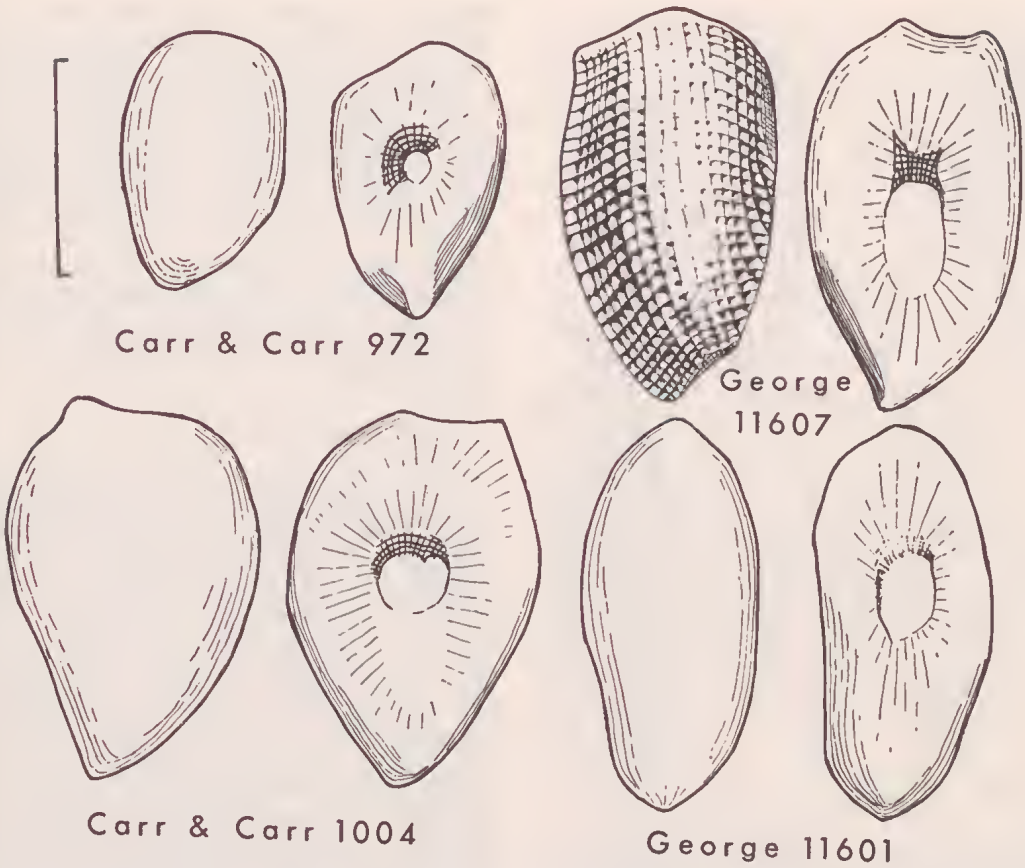


FIG. 6—Seeds. All have the same 'netted' pattern shown for the seed of George 11607. Upper row, Group A. Lower row, Group B. The scale mark, top left, represents 1 cm.

sponding seedling leaves of the Tamala seedlings.

The seedling leaves of the two George specimens show similar differences in shape. George 11601 has broadly ovate leaves. George 11607 has longer, more lanceolate leaves which are relatively narrower than those of 11601. Thus the specimens of Group A have seedling leaves which are relatively narrower and are usually longer than those of Group B, which are ovate, at least half as wide as long.

There are further points of difference between the two sets of seedlings. For instance the oil glands of George 11607 are almost twice as large (diameter 28 μm) as those of 11601 (15 μm). The venation is different, the marginal vein of 11607 being strong, close to the edge of the leaf, while that of 11601 is relatively weak and somewhat distant from the edge. Finally, the minor venation between the marginal vein and the edge of the leaf in each case echoes the characteristics described above for the mature adult foliage. Similar differences are found between the Tamala specimens and Carr and Carr 972. In seedling leaves of the latter the oil glands have a maximum diameter of 30 μm, in those of Carr and Carr 1004 they are no larger than 13 μm. The marginal vein in 972 is strong and close to the edge of the leaf, in 1004 it is weak and consists of a series of loops, distant from the edge and dominated by the costal bundles (Fig. 7). The minor venation within the margin in the 972 seedlings closely resembles that of the adult leaves of the same specimen while that of 1004 resembles its parent's adult leaves. Thus the early seedling leaves of specimens within a Group resemble one another remarkably and show many differences from those of the other Group.

(9) *Tree Form and Bark Character:* Few collections yielded seeds for examination. Even fewer provided information on the tree form and bark character. The Royce specimens were low mallees, 1-1·5 m high. The A. S. George specimens were 'spreading mallees', 11601 a few feet high, 11607 1·5 m high. The Gardner spe-

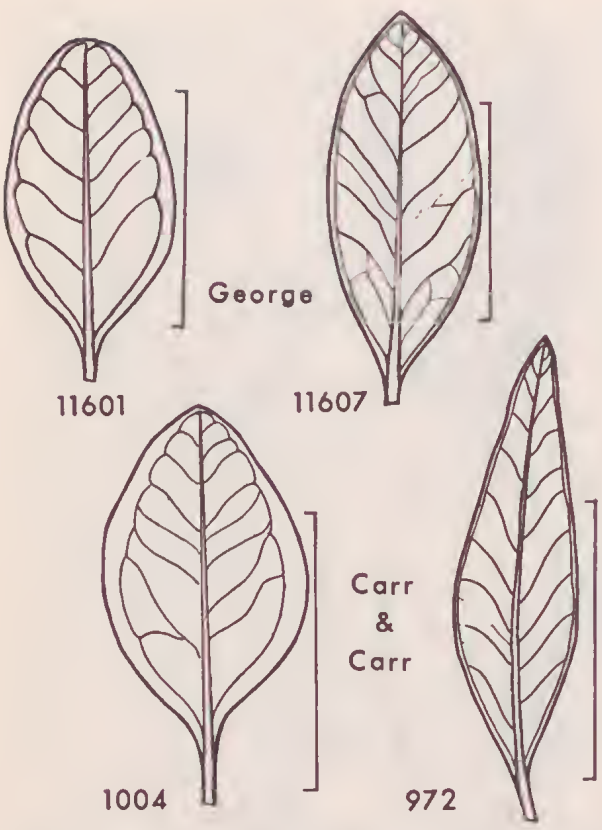


FIG. 7—Seedling leaves, Group A to the right, Group B to the left. The scale marks represent 1 cm. Each leaf is from the 5th pair of a seedling.

cimen was a mallee. The Oldfield specimen from Yatthoo Flat was a 'shrub branched from the root, 6-8 feet tall'. In Bentham (1866) a specimen of Oldfield's is cited under *E. foecunda* as having 'dark, smooth bark'. The Wilson specimen was a mallee, 4 m tall. No specimens of bark were with these or any specimens other than our own. For his 11601, George records 'bark smooth on upper branches, rough lower down', but there are no notes for the bark of 11607. It is possible that in other cases the stems were not considered to have developed a characteristic adult bark. Our larger Tamala specimens were all many-stemmed mallees up to 12 feet high with smooth grey bark on the branches but with rough bark in several layers, peeling in long broad strips from the lower trunks (Pl. 4). In contrast, Carr and Carr 972 was a single-stemmed tree, 6·2 m high with dark grey bark with a brownish tinge which is rough and close-textured (not exfoliating) for about 1·5 m, then smooth on the upper trunk and branches. This tree was typical of others of the same kind in the locality, but tall mallee forms also were present. It is unfortunate that only our own specimens provide information on the form of the mature tree and the nature of the bark on stems which could be regarded as full grown. For the present, we must assume that the mature bark of specimens of Group A is brownish, coarse and close-fitting, while that of specimens of Group B is greyish and exfoliating in long broad strips.

(10) *Stem Anatomy:* All specimens examined proved to have oil glands in the pith. For the Tamala specimens this was already stated in Carr & Carr, 1969.

DISCUSSION

(1) *Two sibling species.* We have shown that the specimens examined can be divided into two groups (listed in Table 1) on the basis of a number of vegetative characters of the adult leaves, the seedlings and of the bark. Differences found in the adult leaves are echoed in the seedling leaves and the seedlings of the two Groups are as distinct as the adults. On the other hand, no clear and consistent differences of the same order have been found in the reproductive structures of the two Groups. There are, it is true, slight differences in size, shape and thickness of the wall of the fruits but to establish these categorically would require special study of a much wider set of collections. Some collectors (George, Royce, Oldfield) have provided specimens of both Groups from the same general locality and there seems to be almost complete overlap in their geographical distribution.

In view of these facts we propose to name the two Groups as separate species, *E. baudiniana* (Group A) and *E. tamala* (Group B). The two must be very closely related—probably sibling—species. To account for their sympatric distribution there must be some barrier to interbreeding. It is possible that the barrier is ecological, perhaps edaphic, but the field data accompanying most of the specimens are quite inadequate to establish any such hypothesis. Most of the area of occurrence has coastal limestone as well as sandy soils. It seems likely that the species are both lime and salt tolerant. It is unlikely that the barrier is phenological—both species flower at about the same time of year (July to September). The barrier could be due to incompatibility in either pollination or fertilization.

No correlations of such characters as leaf gland size, coarseness of venation, fruit, flower or seed size with latitude can be distinguished for either species. Indeed at one locality (Tamala)

the oil gland sizes for *E. tamala* span virtually the whole range for that species. It would appear, therefore, that in their quantitative aspect, these vegetative characters have no particularly strong selective advantage or disadvantage. This strengthens the case for regarding the two Groups as separate species, not as ecotypes of a single species.

(2) *Relationship to other species and specimens.* Since the part of the coast on which these species occur, especially that in Shark Bay, was visited by many of the early explorers of the continent, specimens are likely to have been collected by them. There are specimens in the Paris herbarium of a eucalypt collected in 1801 on the voyage led by Captain Baudin. It will be shown elsewhere (Carr & Carr, in preparation) that this must have been collected on Bernier Island, whence came also two of the Royce specimens. Photographs of the Baudin specimens were presented by Hj. Eichler to the Western Australian Herbarium in 1966. The specimens are labelled 'Côte occidentale de la Nouvelle Hollande' and were annotated by Maiden in 1903 as '*E. incrassata* Labill. v. near *E. foecunda* Schauer'. It seems certain that the N.S.W. specimen 54053, consisting of four detached leaves, six detached umbels of mature flowers and a short twig with a few immature fruits, was given to Maiden from the Baudin specimens. Our examination of it shows it to belong to *E. baudiniana*, and the name is given in honour of N. Baudin. Since Royce has also collected the other species, *E. tamala*, on Bernier Island, and bearing in mind the fact that in their 'low mallee' aspect the two species look extraordinarily alike in the field, it seemed possible that both species might have been collected on the Baudin expedition. However, the Baudin specimen at Kew is also of *E. baudiniana*.

In the same month as Gardner's note on an undescribed species (see Introduction) appeared in print, L. A. S. Johnson was in Western Australia and took the opportunity to try to collect material of it. Subsequently, in 1962, he described, without illustration or reference to Gardner, a single fragment as the type of a new species, *E. oraria*. The locality from which his fragment was collected appears to be unknown or at least uncertain (see Materials and Methods). The specimen has 33 leaves and 13 fruits. There are no flowers or seeds but, invoking a circular argument, Johnson adduced characters of the flowers from other materials, including the Baudin fragments in the N.S.W. Herbarium and the N.S.W. Oldfield specimen, which can both be shown to be not equivalent with his own fragment, the holotype of *E. oraria*. The Drummond specimen is mixed. Thus the description of the species is based on mixed material. The only valid comparisons which can be drawn between the holotype and any other specimens must be made on the basis of the leaves and the fruits. The fruits of the holotype have the valves practically flush with the orifice—a character not shared by any of the other specimens considered above. Unless and until more material can be provided by Johnson, the specimen labelled as the type of *E. oraria* is best relegated to the category of indeterminate fragments which all too often plague the eucalypt taxonomist and which, unless concerning them there are forensic, plant geographical (see Carr & Carr, 1975) or other special questions to be settled, should be disearded or consigned to the 'miscellaneous' box. It is particularly frustrating to have to deal with modern, let alone old, taxonomic entities so poorly authenticated and so vaguely described as *E. oraria*, said by its author to be 'sometimes found in association with *E. dongarraensis*' but which, in fact, has failed to be found again in the type locality of that species, despite diligent search.

The two new species differ from *E. foecunda* in the presence of glands in the pith, in the shape and mode of dehiscence of the anthers and in the orientation of the nectary. They can be distinguished from three other species which grow in the same area and resemble them and each other closely, particularly when all have the form of dwarf mallees, as is often the case. These species all have glands in the pith, anthers with parallel cells and brown netted seeds. If flowers are available *E. loxophleba* Benth. and *E. accedens* W. V. Fitzg. can be recognized on the basis of stamen characters. In both, the filaments are inserted close to the base of the anthers. *E. accedens* has a strongly ornamented cuticle, that of *E. loxophleba* is plain. Both species have biseeted cotyledons. In *E. brachycorys* Blakely the cotyledons are reniform. The stamens resemble those of the new species except that the anthers have short sterile tails and the filaments are inserted on a broad, erect staminophore. However, the characters of the style are more than sufficient to distinguish this species from the two new ones. It is sharply expanded in the upper half and extends beyond the cone of stamens in bud to occupy a pocket in the operculum. The cuticle is ornamented. The situation with regard to *E. brachycorys* is complicated by the existence of one, or perhaps two, related species which are undescribed.

DESCRIPTIONS OF SPECIES

Eucalyptus baudiniana D. J. et S. G. M. Carr sp. nov.

Arbor usque ad 7 m alta vel frutex multicaulis; lignotuber ignota. Cortex brunneola-grisea laevis trunco superiori et ramis, aspera brunneola textu crebro trunco inferiori. Glandulae oleosae cortici desunt, medulla adsunt. Cotyledones reniformes integrae; folia plantularum ovato-lanceolata paribus primus paucis, basim versus latissima, non plus quam dimidio latioria quam longa. Folia matura alternantia, anguste lanceolata ad lanceolata 3·5-8 cm longa, 0·6-1·9 cm lata, vivide viridia nitentia. Rete venarum grossum (ex comparatione eum *E. tamala*), venulae inter venam marginalem et marginem pro ratione parve ramulosae, glandulae oleosae maximae plerumque plus quam 40 μm diametro.

Inflorescentiae pedunculatae, axillares, 7-15 flores. Pedunculus 5-10 mm longus, parum compressus. Flores pedicellis brevibus 6-8 mm longis. Operculum duplex, sepalinum precociter deciduum. Stamina omnia fertilia, omnia in alabastro inflexa. Filamenta alba, saltem ea serierum exteriorum maturitate glandulis oleosis. Antherae loculis parallelibus, rimis longitudinalibus dehiscentes, filamentum medio vel parum infra medium affixum, glandulo ab anteriori non manifesto. Stylus cylindricus, in alabastro cono staminum inflexorum vix longior, stigma stylo latius, stylo glandulis oleosis. Ovula et ovulodia seriebus 4 longitudinalibus, ovula marginalia placentae parti proximali.

Fructus 4-7 mm longus, 3-5 mm latus cylindroideus, basi in pedicellum decrescens, in siccitate vix rugosus. Valvae inclusae (saepe profunde), erectae nectario verticali appressae, triangulares apicibus brevibus obtusis.

Semina brunnea testa reticulata, palea rufo-brunnea, seminibus brevior.

A tree to 7 m tall or a many-stemmed shrub, lignotuber not seen. Bark brownish grey and smooth on upper trunk and branches, rough brownish and close-textured on lower trunk. Oil glands absent from the bark, present in the pith. Cotyledons reniform entire, first few pairs of seedling leaves ovate-lanceolate, widest near the base, not more than half as wide as long. Adult leaves alternate, narrow-lanceolate to lanceolate 3·5-8 cm long, 0·6-1·9 cm wide, bright green and shining. Venation pattern coarse (in comparison with that of *E. tamala*), minor veins between the marginal vein and the margin relatively unbranched, the largest oil glands usually more than 40 μm diameter.

Unit inflorescences stalked, axillary, consisting of 7-15 flowers. Peduncle 5-10 mm long, slightly compressed. Flowers shortly stalked, 6-8 mm long. Operculum double, the sepaline one shed early. Stamens all fertile, all inflexed in bud. Filaments white, oil glands present at maturity at least in those of the outer rows. Anthers with parallel cells, dehiscing by longitudinal slits, filament inserted at or just below the middle, gland not visible from the front. Style cylindrical, scarcely longer than the cone of inflexed stamens in bud, stigma wider than style, style with oil glands. Ovules and ovulodes in 4 longitudinal rows, the ovules marginal on the proximal part of the placenta.

Fruits 4-7 mm long, 3-5 mm wide cylindroid and tapering into the pedicel, scarcely wrinkled when dry. Valves included (often deeply), erect against the vertical nectary, triangular with short blunt tips.

Seeds brown, surface of testa netted, chaff reddish brown, shorter than the seeds.

TYPE: Bungabandi Creek Road, 36 miles from junction with North-west Coastal Highway (approx. 27°S, 15°22′E). 25 June 1969, D. J. and S. G. M. Carr 972 (holo: PERTH).

DISTRIBUTION: Coastal areas of Western Australia between Bernier Island and Geraldton, inland as far as Perenjori.

Eucalyptus tamala D. J. et S. G. M. Carr sp. nov.

Frutex multicaulis usque ad 3 m alta; lignotuber adest. Cortex grisea, laevis trunco superiori; aspera, fibrosa, exfolians in lacinias longas, latas trunco inferiori. Glandulae oleosae cortici desunt, medulla adsunt. Cotyledones reniformes integrae; folia plantularum prima ovata, minus quam bis longiora quam lata, apice rotundata vel in apiculum obtusum contracta, vena marginali profundi-lobata. Folia matura alternantia, anguste lanceolata ad lanceolata, 3·5-9 cm longa, 0·8-1·9 cm lata, vivide viridia nitentia. Rete venarum tenue densum, venulae inter venam marginalem et marginem multo ramosae, glandulis oleosis numquam plus quam 38 μm diametro.

Inflorescentiae pedunculatae, axillares, 7-15 flores, pedunculo 5-10 mm longo, parum compresso. Flores pedicellis brevibus 6-8 mm longis. Operculum duplex, sepalinum precociter deciduum. Hypanthium operculo longius. Stamina omnia fertilia, omnia in alabastro inflexa. Filamenta alba, saltem ea serierum exteriorum maturitate glandulis oleosis. Antherae versatiles rimis longitudinalibus dehiscentes, filamentum medio vel parum infra medium affixum, glandulo ab anteriori non manifesto. Stylus cylindricus, in alabastro cono staminum inflexorum vix longior, stigmate tam lato quam stylo. Glandulae oleosae parti inferiori styli tantum adsunt. Ovula et ovulodia seriebus 4 longitudinalibus, ovula marginalia placentae parti proximali.

Fructus 5-9 mm longus, 3·5-5 mm latus, sessilis vel subsessilis, plerumque obconicus vel obpyriformis, abrupte orificium versus contractus, cristis irregularibus plus minusve longitudinalibus, loculis 3 vel 4. Valvae profunde inclusae, triangulares apicibus brevibus obtusis, erectae nectario verticali appressae.

Semina brunnea usque ad 1·8 mm longa, 1·0-1·2 mm lata, testa reticulata. Palea aurantiaco-brunnea, seminibus brevior.

A many-stemmed shrub (mallee) up to 3 m tall, lignotuber present. Bark smooth and grey on upper trunk, coarse, fibrous and exfoliating in long, broad strips from the lower trunk. Oil glands absent from bark but present in the pith. Cotyledons reniform, entire; first seedling leaves ovate, less than twice as long as broad, rounded at the tip or tapering to a blunt point, marginal vein deeply-lobed. Adult leaves alternate, narrow lanceolate to lanceolate, 3·5-9 cm

long, 0·8-1·9 cm wide, bright green and shining, oil glands never more than 38 μm diameter. Venation fine and dense, small veins between margin and marginal vein much branched. Unit inflorescences axillary, stalked, consisting of 7-15 flowers, peduncles 5-10 mm long, slightly compressed. Buds shortly-stalked, 6-8 mm long. Operculum double, the sepaline one falling early. Hypanthium longer than the operculum. Stamens all fertile, all inflexed in bud, filaments white, those of at least the outer rows containing oil glands at maturity. Anthers versatile, dehiscing by longitudinal slits, filaments inserted at or slightly below the middle, gland not visible from the front. Style cylindrical, scarcely longer than the cone of inflexed stamens in bud, stigma as wide as the style. Oil glands present only in the lower half of the style. Ovules and ovulodes in 4 longitudinal rows, the ovules marginal on the proximal part of the placenta. Fruits 5-9 mm long, 3·5-5 mm in diameter, sessile or nearly so, usually obconical or obpyriform, contracted abruptly to the orifice and with irregular, more or less longitudinal, ridges, loculi 3 or 4. Valves deeply included, triangular with short blunt tips, erect against the vertical nectary. Seeds brown, up to 1·8 mm long, 1·0-1·2 mm wide, testa netted. Chaff orange-brown, shorter than the seeds.

TYPE: Roadside (Tamala Station Road), 26 miles from junction with Denham Road (26°35′S, 113°55′E). 27 June 1969, D. J. and S. G. M. Carr 1003 (holo: PERTH).

DISTRIBUTION: Coastal areas of Western Australia between the latitudes 24°45′S and 29°S, Bernier Is., Dorre Is., Dirk Hartog Is., Houtman Abrolhos.

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DESCRIPTION OF PLATES 1-4

Plate 1

Photographs of middle portions of cleared adult leaves representative of Group A (all to the right) and Group B (all to the left) (all × 12).

1. A. S. George, 11601. 2. A. S. George, 11607. 3. Royce, 5967. 4. Royce, 6018. 5. Carr, 394. 6. Gardner.

Plate 2

Photographs in polarized light of the margins of adult leaves of specimens of Group A (the two rows to the right) and of Group B (the two rows to the left). The photographs show the marginal vein (to the left) and the margin (to the right). The marginal vein of no. 6 is to the left and out of the field of the photograph. (All × 25.)

1. Main. 2. George, 11601. 3. George, 11607. 4. Wilson, 6018. 5. Serventy. 6. Royce. 7. Royce, 5982. 8. Baudin, N.S.W. 54053. 9. Ford. 10. Carr & Carr, 1003. 11. Carr & Carr, 972. 12. Burbidge.

Plate 3

Photographs of median sections of stomata of adult leaves of specimens representative of Group A (1-4) and Group B (5-8) (all × 300).

1. George, 11601. 2. Royce, 6018. 3. Serventy. 4. Carr & Carr, 394. 5. George, 11607. 6. Royce, 5982. 7. Carr & Carr, 972. 8. Wilson.

Plate 4

Photographs to show the habit and bark character of *E. baudiniana* (1-3) and *E. tamala* (4, 5). No. 1 is Carr and Carr, 972; 2 shows the shining leaves; 3 is a close-up of the lower part of 2 (arrow) and shows the smooth bark on the young stem and close-grained bark on the lower trunk. No. 5 is a group of mallees on the Tamala Station Road and 4 shows the bark exfoliating from the lower trunk of one of the stems.